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Ontology for Life-Cycle Modeling of Water Distribution Systems: Application of Model View Definition Attributes

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Prepared under CRADA-07-CERL-02 under the supervision of

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Abstract

Previous efforts by the US Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) to develop a life-cycle building model have resulted in the definition of a "core" building information model that contains general information describing facility assets such as spaces and equipment. To describe how facility assets (i.e., components) function together, information about assemblies of assets and their connections must also be defined. The definitions of assets, assemblies, and connections for the various building-information domains are discipline-specific. Work documented in ERDC/CERL CR-13-4 identified the processes and tasks specifically associated with the design of interior plumbing systems and the information exchange requirements for every participant in the design. The findings were used to develop an information-exchange Model View Definition (MVD) for building water systems.

The objective of the current work was to document the steps needed to identify the plumbing MVD attributes in three experimental building information models representing typical low-rise Army facilities, and to update those models. This work also validated the International Foundation Class (IFC) export function from the experimental models against the water system MVD, and studied the requirements for creating computable open building models that can be utilized for the automated information exchanges.

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Preface

This study was conducted for the US Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) and the National Institute of Building Sciences (NIBS) by Kristine Fallon Associates Inc., and Constructivity.com, LLC, under CRADA-07-CERL-02, "Cooperative Research and Development Agreement Between US Army Engineer Research and Development Center–Construction Engineering Laboratory and National Institute Of Building Sciences." The CRADA supports Research, Development, Test, and Evaluation (RDT&E) Program Element 622784 T41, "Military Facilities Engineering Technology"; Project 157249, "Life-Cycle Model For Mission Ready Sustainable Facilities (LCM)." The ERDC-CERL project manager was Dr. E. William East (CEERD-CF-N), and the NIBS project manager was Dominique Fernandez.

The work was supervised and monitored by the Engineering Processes Branch (CF-N) of the Facilities Division (CF), ERDC-CERL. At the time of publication, Donald K. Hicks was Chief, CEERD-CF-N; L. Michael Golish was Chief, CEERD-CF; and Martin J. Savoie, CEERD-CV-ZT, was the Technical Director for Installations. The Deputy Director of ERDC-CERL was Dr. Kirankumar Topudurti and the Director was Dr. Ilker Adiguzel.

COL Kevin J. Wilson was the Commander of ERDC, and Dr. Jeffery P. Holland was the Director.

Unit Conversion Factors

Multiply	By	To Obtain
cubic inches	1.6387064 E-05	cubic meters
cubic yards	0.7645549	cubic meters
degrees (angle)	0.01745329	radians
feet	0.3048	meters
gallons (U.S. liquid)	3.785412 E-03	cubic meters
miles (U.S. statute)	1,609.347	meters
mils	0.0254	millimeters
square feet	0.09290304	square meters
square inches	6.4516 E-04	square meters
square miles	2.589998 E+06	square meters
square yards	0.8361274	square meters
yards	0.9144	meters

1 Introduction

1.1 Background

Previous efforts by the US Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) to develop a life-cycle building model have resulted in the definition of a "core" building information model that contains general information describing facility assets such as spaces and equipment (East, Love, and Nisbet 2010). To describe how facility assets (i.e., components) function together, information about assemblies of assets and their connections must also be defined. The definitions of assets, assemblies, and connections for the various building-information domains are discipline-specific. Taken together, studies of all essential building-information domains will create a unified framework for developing automatic design checks, ensuring construction compliance, improving operations and maintenance efficiency, and evaluating alternatives for redesign within completed facilities.

COBie (East 2007) was the first step in analyzing information exchanges in the life cycle of a building. Since March 2012, COBie has been part of the National BIM Standard–United States (NBIMS-US). COBie defines the format for providing information about building assets from the planning phase through design, construction, and operations. Properties of these assets may also be captured in the COBie date exchange format. The *COBie Guide*, a commentary on the COBie standard (public draft downloadable at link from http://www.nibs.org/?page=bsa_cobieguide), does not prescribe how to model specific assemblies of components or how components and assemblies are connected. Those aspects of modeling and information exchange require a domain-specific ontology for every system needed to construct a functional building. Subsequent work led to the development of a Model View Design (MVD) for the design of water distribution systems in typical Army facilities. That MVD is documented in ERDC/CERL CR-13-4 (Chipman et al. 2013).

In order to provide a foundation for testing and validating research on building life-cycle topics, ERDC-CERL led the development of experimental core building information models for three common facility types widely used on Army installations: a Duplex Apartment, a Medical Clinic, and an Office Building (East 2012a). The present report documents the

application of the water distribution system MVD to those experimental models as part of the effort to create formal specifications applicable to open-standards BIM at the coordinated design stage of construction.

1.2 Objectives

The main objective of this work was to document the steps needed to identify the water system MVD attributes in the three experimental BIMs and update the models. This work also validated the International Foundation Class (IFC) export function from the experimental models against the MVD, and studied the requirements for creating computable open building models that can be utilized for the automated information exchanges.

1.3 Approach

In this report, the term *water distribution systems* encompasses the plumbing supply and waste removal systems for flow delivery terminals such as sinks, toilets, showers and bath tubs. The present work applies the process flows and data exchanges requirements for the design of interior water distribution systems in typical Army facilities. These processes and exchange requirements were used to create a Model View Definition (MVD) procedures (see Chipman et al. 2013) specified by the International Organization for Standardization (ISO) and buildingSmart International (e.g., Hietanen 2008).

The water system process flow and exchange requirements were applied to a simulated real-world situation to study how the information exchanges can be handled in COTS BIM software using the three experimental models noted above. These "core" BIMs represent typical low-rise facilities commonly built on Army installations. Water distribution equipment and systems were updated using commercial off-the-shelf (COTS) BIM software and a native common object library developed in that software. Coordinated IFC models were then generated using the COTS IFC export capability.

The models act as a test bed for the MVD and the COTS tools available at the time the work was performed. While the results will change with time, as software is updated to accommodate this and potentially other new MVDs, the procedures described here can be used by others to evaluate their software and design processes.

2 Experimental Building Models

2.1 Overview

This chapter documents the procedure followed for the design-phase modeling and IFC export of water systems equipment found in three typical Army facilities: a Duplex Apartment, an Office Building and a Clinic. The goal of this process is to produce model files in the native COTS BIM-authoring software and IFC formats for the information exchange of water system design information. The three example models produced by this process can serve as reference data for future experimentation by ERDC and testing by software developers and end users.

The starting points for the modeling were previously developed architectural and mechanical/electrical/plumbing (MEP) experimental models (East 2012a). These models were initially developed using Revit 2011, which was current at the time the models were created. In the present work, Revit 2013, Update Release 2, build 20121003_2115(x64), was used. As Revit versions are not backward compatible, the models produced for the current project cannot be used within Revit 2011.

It should be noted at the outset that this MVD is based on IFC4, which had not been officially approved at the time this work was undertaken. As stated in Chipman et al. 2013 (p 49):

> While most product geometry information was already well-defined within IFC version 2x3 and implemented by many vendors, there were many concepts that required some of the lesser-supported IFC data structures and some that required the expanded MEP scope in IFC version 4 to achieve adequate levels of detail... While realizing that many of these concepts were not supported by existing COTS software, the MVD has been defined to allow partial compliance for now, but with allowances to later relax or replace some requirements after testing models produced by existing software .

Therefore, one cannot fault Revit 2013 (the selected COTS software, which was designed to use IFC2x3) for not handling the IFC4 concepts. In fact, as

noted below (section 2.6), the tests used to validate conformance to the MVD were relaxed to take account of the IFC4 concepts.

The Revit models were edited to remove non-water system interior elements so that the tests of the water system MVD would not contain extraneous information. Families and groups not related to testing the water system MVD were deleted from the model.

The following sections describe creating the Revit 2013 water system design models and exporting these models to IFC. Details on the modeling of each building type are given below in separate sections.

Table 1 provides statistical information for each of the three models.

Table 1. Model statistics.

Model Statistics	Duplex	Office	Clinic
Native file size	23.8MB	23.5MB	34.9MB
IFC file size	31.3MB	58MB	92.4MB
Building Area	3,372 sq ft	40,053 sq ft	49,571 sq ft
No. of Spaces	21	99	266
No. of types	24	24	36
No. of Components	40	88	377

2.2 Determination of additional water system properties

In order to meet the requirements of the Water System MVD, additional properties must be added to those already on the water system elements in the experimental Revit models. That additional properties are needed is not a fault in the software used or the original models – it simply underscores the notion that, as new information exchanges are defined, additional properties can be added to the models to accommodate the new uses that the new MVD provides.

The following procedure was used to determine the required properties:

1. Using the schedules in the Revit models, a spreadsheet listing the water system element types was created and the occurrence of each type in the three models was noted (Appendix A).

2. A list of the property sets and properties for these element types was extracted from the MVD and added to the spreadsheet for each type.
3. The list of properties needed by the Water System MVD was compared to the list of properties already on the elements in the Revit models to create a list of the properties that needed to be added to the element types in the model. This list is shown in Appendix B.

The time needed to identify the needed properties will depend on the complexity of the model, but can take a day or two.

2.3 Addition of water system properties to the Revit experimental building models

The base architectural and MEP Revit models were downloaded from the Building Smart Alliance website, http://buildingsmartalliance.org/index.php/projects/commonbimfiles/.

The following steps were followed to update and expand these models:

1. Non-water system elements were removed from the models so that the IFC export would include only the target water system elements and the building architectural elements necessary to define the floors, rooms and spaces.
2. Additional water system elements were added as needed.
3. Additional properties were added to the water system elements as needed. This process can take a day or two, depending on the complexity of the model. It is recommended that a copy of the original model be retained, since if errors are made, it is often easier to revert to the original model than it is to remove the incorrect properties.
4. Default values were assigned to element parameters.
5. Project parameters were updated.

2.3.1 Removing nonessential elements from the models

Nonessential building interior features, such as furniture, casework, electrical elements and mechanical systems, were deleted from the model.

2.3.2 Modeling additional water system elements

Since the water systems in these buildings models are relatively completely developed, little additional modeling was needed. The main cause for

additional modeling related to the fact that the original experimental BIMs used single Revit element types to represent objects that need to be treated as separate elements for water system analysis and validation of the MVD. As one example, the Revit M_Bath Tub:1525 mmx760 mm – Private element includes hot and cold water connectors and a representation of a faucet. This faucet, however, does not have the properties and IFC categorization needed to properly export and validate. Therefore, separate faucet elements were used for the tubs, showers and sinks in the water system BIMs.

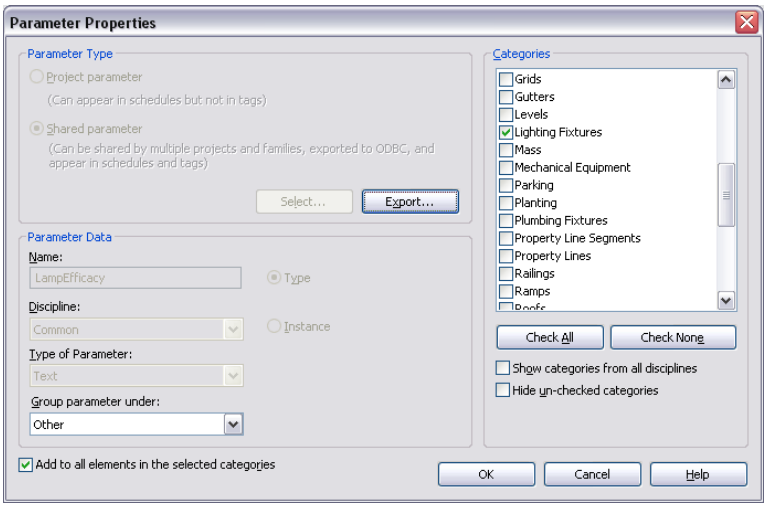
2.3.3 Adding properties to elements in the models

In order to include the water system properties that were identified in section 2.2 on the families in the building model, it was necessary to directly update the families in Revit with the new parameters.

The following procedure was used to add required parameters to the models:

1. The Revit MEP model for the Duplex Apartment—Duplex_MEP.rvt — was opened in Revit 2013.
2. New Revit Shared Parameters for each of the new water system properties were added to the COBieSharedParameters.txt file using the **Revit Manage tab > Shared Parameters** command. The resulting shared parameter file was saved as COBieSharedParameters - Ontologies MVD-Water.txt.
3. The new Shared Parameters were added to selected element categories using a proprietary custom add-in program. (Steps 2 and 3 can also be done using the **Revit Manage tab > Project Parameters > Add** command.)
4. A copy was made of the “COBie Types Schedule,” a multi-category schedule in the Duplex Apartment Model file, re-named where necessary based on the corresponding Revit Category and updated to include the new parameters.
5. The new parameters were edited in the **Schedule Properties** dialog box to apply the parameters to the appropriate element categories in the model (Figure 1).

Figure 1. Revit parameter properties dialog box showing the lamp efficiency property applied to lighting fixtures.



6. For the other models and the Revit Experimental BIM template (.RTE) files, each file was opened in Revit 2013 and the plumbing schedules created were copied into it from the first model. Copying the schedule into the model applies the shared parameters to the building elements in the model.

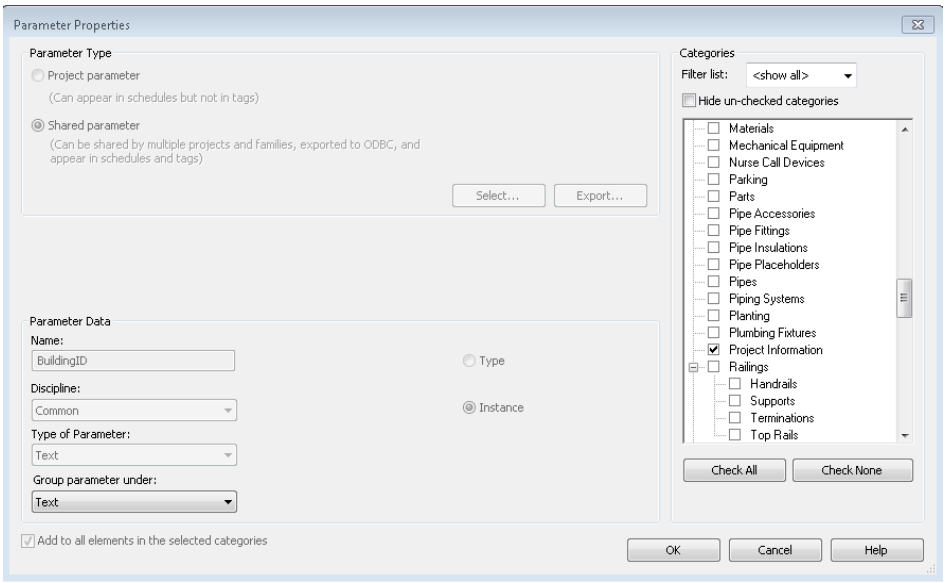
2.3.4 Assigning default values

Revit does not export to IFC custom parameters that do not have assigned values. Therefore, in order to be able to export all of the additional water system parameters to IFC, default values (such as 0, UNSET, or N/A) were set using a proprietary custom add-in program. (Values could also have been set by editing the Revit schedules of the water system elements.)

2.3.5 Updating project parameters

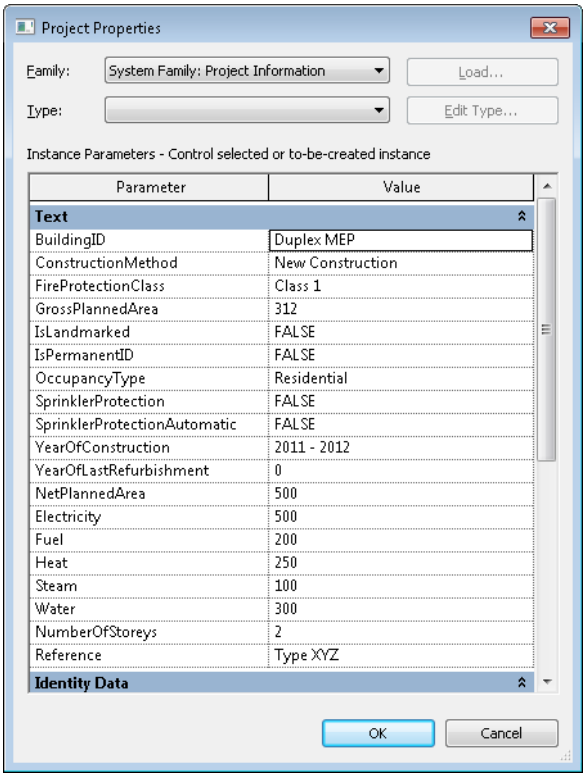
The procedure for adding additional properties to the overall project were similar to the steps outlined in section 2.3.3, Adding Additional Properties to Elements in the Models. All shared parameters associated with the overall project were added as Project Parameters and associated with the Project Information category (see Figure 2).

Figure 2. Revit Parameter Properties dialog box showing the building ID property applied to Project Information.



This category cannot be scheduled. These parameters were updated with the correct values by navigating to the Project Properties dialog box (**Revit Manage tab > Project Information**) and typing the values.

Figure 3. Revit Project Properties dialog box showing the building parameters.



2.4 Export of the models to IFC

Once the building models had been edited to expand the water system model and remove extraneous elements, new properties added to the models and applied to the building elements in the models, and default values assigned, the models were ready to export to IFC files.

2.4.1 Revit IFC export

The basic procedures for successfully exporting the Revit model to IFC are outlined in ERDC/CERL CR-11-2 (Johnson and Fallon 2011).

Because of changes in Revit's IFC export between the 2011 and 2013 releases, some of the values of the IfcExportAs and IfcExportType override parameters needed to be changed. (The Revit 2011 settings from Johnson and Fallon [2011] for water system elements are reproduced in Table 2.)

Table 2. IFC export override parameter settings.

Revit Family	IfcExportAs	IfcExportType
M_Bath Tub.rfa	IfcSanitaryTerminalType	BATH
M_Drinking Fountain - Rectangular - Wall Mounted.rfa	IfcSanitaryTerminalType	SANITARYFOUNTAIN
M_Floor Drain - Round.rfa	IfcPipeFittingType	ENTRY
M_Hot Water Boiler - 59-440 kW.rfa	IfcBoilerType	WATER
M_Inline Pump - Circulator.rfa	IfcPumpType	CIRCULATOR
M_Lavatory - Oval.rfa	IfcSanitaryTerminalType	SINK
M_Roof Drain.rfa	IfcPipeFittingType	ENTRY
M_Shower Stall - Rectangular.rfa	IfcSanitaryTerminalType	SHOWER
M_Sink - Island - Single.rfa	IfcSanitaryTerminalType	SINK
M_Sink - Kitchen - Double.rfa	IfcSanitaryTerminalType	SINK
M_Sink - Work.rfa	IfcSanitaryTerminalType	SINK
M_Urinal - Wall Hung.rfa	IfcSanitaryTerminalType	URINAL
M_Water Closet - Flush Tank.rfa	IfcSanitaryTerminalType	WCSEAT
M_Water Closet - Flush Valve - Wall Mounted.rfa	IfcSanitaryTerminalType	WCSEAT
M_Water Heater.rfa	IfcTankType	PREFORMED

The Revit model was exported to IFC using the IFC-exportlayers.txt file created for the Experimental BIM project (East 2012a). The IFC-

exportlayers.txt file provides additional Revit-to-IFC mappings to enable correct export of the Revit elements and properties to IFC (see Johnson and Fallon 2011 for more details).

2.4.2 Special considerations regarding Revit IFC export

Several special considerations that apply to Revit's IFC export functionality affect the completeness of the IFC file and its validation against the MVD. It should be noted that since the version of Revit 2013 used in this work (20121003_2115 [x64]) was released, changes have been made to the open source Revit IFC export code. Users who wish to use the latest Revit IFC export code should get the latest version of the open source Revit exporter plug-in, either from SourceForge (http://sourceforge.net/projects/ifcexporter/files/2013) or from the Autodesk Exchange App Store (http://apps.exchange.autodesk.com/RVT/Home/Index).

- Property values that should be numeric but that have a unit text, such as '208 V' for 208 volts, get incorrectly converted in the IFC export. For example, '208 V' exports as '2238.89'. This is a known issue in Revit. The Revit API *GetParameter* function returns values in a mixture of imperial units for length and metric units for everything else. So volts, which can be expressed as (kg * m^2) / (A * s^3), get returned as (kg * ft^2) / (A * s^3). Note that 2238.89/208 is approximately 10.76, or in other words 1 m^2/1 ft^2 (Valdez 2012). This problem has reportedly been fixed in the Open Source code.
- At the time Revit 2013 was released, IFC4 had not been approved, so it is not supported. Because the water system MVD is written to take advantage of IFC4, adjustments were made to the validation tests to account for the fact that Revit exports to IFC 2x3.

2.5 Validation of the Revit 2013 IFC export

The exported IFC files for the three BIMs were checked against the Water System MVD using the ifcDoc tool (downloaded from http://www.buildingsmart-tech.org/specifications/specification-tools/ifcdoc-tool). IfcDoc is a Microsoft Windows program that automates IFC documentation generation for both baseline IFC documentation as well as model view definitions. It supports generating boilerplate text from templates, hyperlinks, EXPRESS definitions, figures, tables, contents, and indices. It can also import MVD-XML and file and validate IFC files for conformance to that MVD. Additional information on out validation

methodology is presented in Appendix C. Additional information on using the ifcDoc tool can be found at http://www.buildingsmart-tech.org/specifications/specification-tools/ifcdoc-tool/ifcdoc-help-page.

Because the water system MVD was based on IFC4, which was unofficial at the time this work was undertaken, Revit 2013 does not support IFC4 concepts. Adjustments to the requirements of the MVD were made in ifcDoc to make some IFC4 concepts optional. Other modifications were made to simplify the report format and combine similar error reports into single line items.

As model view definitions have historically been defined by their documentation only (no computer interpretable rules), validation has typically been a manual process requiring human interpretation of documentation and authoring of programming code to test IFC files.

BuildingSmart International established the mvdXML format as a way to automate the validation process such that future model view definitions may be validated without custom programming. The water system model view definition presented here was one of the first to leverage mvdXML. At the time this MVD was authored, mvdXML 1.0 had been finalized and approved, but validation tools were not readily available.

The Global Testing Documentation Server tool (gtds.buildingsmart.com; registration required) was scheduled to support mvdXML validation at the time of IFC4 final release (previously scheduled for July 2012), however the IFC release schedule was extended to accommodate ISO approval, with the result that the mvdXML validation tools were not yet integrated into GTDS as of late 2012, when the present work was completed.

The Open Source Building Information Modelserver (bimserver.org) also indicated intentions of supporting mvdXML validation, but that support was delayed due to resource availability. As of February 2013, a developer has actively been working on mvdXML integration. The timeline for this work required validation tools late in 2012. To accommodate this schedule, several alternatives were considered: (a) exclude validation efforts; (b) postpone validation until tools are available; or (c) invest resources out-of-pocket in creating such tools. The latter option was selected, and the researchers worked with buildingSmart International to expand the IfcDoc tool to support integrated validation of model view definitions. To help

streamline other efforts, the utility was adapted to support integration with server tools such as those described above.

The report in Appendix C (Table C3) was generated by the IfcDoc validation tool, an open-source utility available at http://www.buildingsmart-tech.org/mvd. The report is organized by IFC entity, with concepts underneath each entity. Columns are shown for on the right for each exchange, identified by number (see Table C1). The symbols in the column indicate the status of each test (see Table C2).

A small set of the concepts tested relied on IFC4, but are not found in IFC2x3. Ultimately, the goal of these model view definitions is to provide the necessary information to actually build a building. For example, port typing in particular is necessary to understand how equipment is connected, and to analyze systems for required capacity and conformance to building code; IFC4 supports identifying port types and system types unambiguously. Another such critical concept was classification. While that is also possible in IFC2x3, IFC4 provides an enforceable syntax to ensure that classifications are interoperable across files. Additionally, there were some specific IFC4 concepts leveraged for certain exchanges, such as occupancy schedules, projected energy usage, and resource allocations. To distinguish between IFC2x3 and IFC4 concepts, each IFC4-dependent concept is noted in Table C3 and overall statistics were calculated for both IFC2x3 and IFC4.

Ultimately, market-available software was found that could produce files 100% in conformance with some of the exchanges for IFC2x3. The more advanced concepts that failed the validation provide room to push the industry forward toward greater detail and better interoperability.

An overall summary of the MVD validation report is provided below in Table 3 and a detailed summary in Table C4. The percentages of non-compliant items are also provided and associated with the possible cause. Appendix C, Table C3, presents the validation results broken down by the specific exchange and Table C4 presents a summary of the numbers. The summary in Table 3 identifies the applicable concepts, number of passing concepts, and the percentage of concepts that passed the validation check, based on all of the object instances in the model. Table C3 shows the validation results based on each separate information exchange and presents

percentages passing based on the number of rules checked, not the number of instances.

Table 3. IfcDoc MVD report summary.

Water Systems MVD Validation	Duplex	Office	Clinic
Tests Applicable	408	408	408
Tests Passing All Exchanges	368	368	373
Optional Tests Failing Any Exchange (number)	22	22	18
Optional Tests Failing Any Exchange (percent)	5.4%	5.4%	4.4%
Mandatory Tests Failing Any Exchange (number)	18	18	17
Mandatory Tests Failing Any Exchange (percent)	4.4%	4.4%	4.2%
Percent of Rules Passing (IFC4)	95-99%	95-99%	96-99%
Percent of Rules Passing (IFC2x3)	97-100%	97-100%	97-100%
Causes of Non-Compliance, as a percentage of total non-compliant concepts:			
IFC4	61%	61%	61%
Revit IFC Export hard-coded to null	17%	17%	17%
Values not assigned in the code	22%	22%	22%

As indicated in Table 3, about 5% of the 408 tests failed for at least one optional exchange for the all three buildings; about 4% failed at least one mandatory test for the Duplex Apartment and Office Building and about 10% for the Clinic. The overall failure rate for all tests, looked at for each exchange separately, ranged from 1% to 5% for IFC4 tests and from 0% to 3% for IFC2x3 tests. Not unexpectedly, none of the 19 exchanges passed all of the IFC4-related tests, but only 2 of the 19 exchanges passed all of the IFC2x3 tests.

Overall, the Entities (Item), Concepts (Sub-Items), and Problems related to the possible Causes of non-compliance are listed below in Table 4. Refer to Chapter 3 of Chipman et al. (2013) for discussion of Entities and Concepts as related to MVDs.

Table 4. IfcDoc MVD non-compliance items.

Item	Sub-Item	Problem	Cause
IfcSite	Site Location	Physical address is needed for determining applicable building codes	Hard-coded to null in Revit IFC export
IfcBuilding	Classification	OmniClass address needed for classifying building to determine code requirements	IFC4
IfcBuilding	Product Assignment	Tasks and resources are assigned to building structures to indicate plumbing fixture requirements in early design without specific product or placement indicated.	IFC4 No support for tasks or resources in Revit
IfcBuilding	Building Location	Elevations needed to determine utility connectivity	Hard-coded to null in Revit IFC export
IfcSpace	Classification	OmniClass address needed for classifying space to determine designed electrical usage per square foot	IFC4
IfcSanitaryTerminalType	Property Sets for Types	Manufacturer type information necessary to identify, order, and price products	Variable created in Revit IFC export code, but no values are assigned
IfcSanitaryTerminalType	Type-Based Ports	Ports may be specified on types	IFC4 (Possibly in IFC2x3 but not documented)
IfcPipeFittingType	Property Sets for Types	Manufacturer type information necessary to identify, order, and price products	Variable created in Revit IFC export code, but no values are assigned
IfcPipeSegmentType	Property Sets for Types	Manufacturer type information necessary to identify, order, and price products	Variable created in Revit IFC export code, but no values are assigned
IfcPipeSegmentType	Material Profile Set	Materials are placed in cross-sections of specified dimensions following a path defined at occurrences of the type	IFC4
IfcPumpType	Property Sets for Types	Manufacturer type information necessary to identify, order, and price products	Variable created in Revit IFC export code, but no values are assigned
IfcPumpType	Type-Based Ports	Ports may be specified on types	IFC4 (Possibly in IFC2x3 but not documented)
IfcDistributionPort	Property Sets	Port property sets indicate pipe connectivity, including nominal diameter and connection types.	IFC4 (Possibly in IFC2x3 but not documented)
IfcDistributionPort	Material Profile Set Usage	Material profiles indicate actual cross-sections and the alignment axis for pipes and connections, allowing for parametric layout of piping systems.	IFC4
IfcDistributionPort	Port Connectivity	Port connectivity necessary to determine flow path and calculate required design parameters (pressure, temperature, volumetric flow rate).	Object placement hard-coded to null in Revit IFC export
IfcValveType	Property Sets for Types	Manufacturer type information necessary to identify, order, and price products	Variable created in Revit IFC export code, but no values are assigned
IfcValveType	Type-Based Ports	Ports may be specified on types	IFC4 (Possibly in IFC2x3 but not documented)

2.6 Issues

Revit family categories are very broad currently. For example, only high level categories for plumbing fixtures are provided. The *Plumbing Fixtures* family category is intended to capture *all* plumbing fixture types i.e. toilets, sinks, drinking fountains, etc. The issue with this high level grouping arises when applying attributes from the shared parameters file to the fixtures. For example, attributes intended for a urinal were also applied to every other fixture (sinks for example) within the *Plumbing Fixtures* family category. This would require the user responsible for inputting values to either review the MVD documentation or have a thorough understanding of attributes associated with various plumbing equipment to understand which attributes require values. Although filters can be applied to schedules within Revit to hide non-applicable attributes for a particular fixture type, there is potential for non-applicable attributes to be overlooked and values inserted that would lead to incorrect data being exported out for a plumbing fixture type.

Being able to either create more family and/or sub-categories and being allowed to apply shared parameter attributes at the sub-categories level would provide an efficient method for associating only the applicable attributes to various plumbing equipment objects.

3 Summary, Conclusions and Recommendations

While the subject matter experts interviewed in the first stage of this project (Chipman et al. 2013) showed a diversity of project delivery methods and specific workflows, it was possible to define role-based information exchanges that were broadly applicable. The information exchanges identified in these workflows established the basis for developing the water systems MVD. Although IFC2x3 was the current standard at the time of this report, the water systems MVD was written for IFC4. IFC4 was used due to its expanded capabilities for describing interior plumbing schemas. The final version of IFC4 is scheduled to be released in 2013 and it is anticipated that the issues identified in this report related to IFC4 will be addressed once IFC4 is officially released and adopted by software vendors.

Using the water systems MVD, additional required properties were identified for the plumbing elements in the experimental BIMs and added to the models. Based on the results received after updating each of the BIMs with the additional MVD attributes, converting the BIMs to IFC, and analyzing the data utilizing the ifcDoc tool, it can be concluded that the current COTS version of Revit 2013, Update 2, is capable of capturing and managing the necessary information within the BIMs.

Although the water systems MVD is new and still preliminary, and thus not supported by COTS software, and Revit does not claim to have extensive IFC 2X3 export support for MEP systems, the validation reports generated by the ifcDoc tool indicated that almost two-thirds of the included concepts were successfully exported to IFC. The validation reports indicated that the three main causes for noncompliance were:

- concepts and properties introduced in IFC4
- property values that are hard-coded to null in Revit IFC export
- property values are not assigned in the Revit IFC export code.

During the process of adding MVD attributes to the models using the shared parameters method in Revit 2013, it was discovered that plumbing objects were too broadly categorized to effectively associate specific attributes with the appropriate components. This situation meant that attributes

appropriate for a urinal, for example, would also be applied to other plumbing fixtures such as sinks or bathtubs.

In the process of conducting this research, it became clear that describing and maintaining the systems and connections between elements in the BIM is essential to extracting useful data for the information exchanges described by this MVD. This requirement has implications both for the way some plumbing elements are defined in the COTS software and for the way a typical BIM design project subdivides the model:

- Some BIM families (e.g., sinks) can belong to different systems and even different disciplines, and might be better modeled if broken into separate components. For sinks, this means that the body of the sink attaches to the waste water system, while one valve of the faucet attaches to the hot water system and the other to the cold water system.
- The common method of subdividing large projects by floors or even by parts of floors can sever the system connections between elements in different parts of the model. Without these system connections, some of the information needed for the information exchanges in the MVD is lost. New ways of subdividing large models are needed that will preserve both the system and the contextual information.

The modeling work described in this report demonstrates that it is possible, recognizing some limitations in the current software, to use the new MVD to add properties to the BIM and export that information to IFC, where it can be used for further analyses. If future software releases address the issues noted above, the BIMs will have the ability to achieve greater interoperability by providing the additional information that teams require during the design phase.

Looking to the future, although the IFC2x3 Coordination View has been sufficient for BIM use in the industry to date, it is time for vendors to support the entire IFC data model more fully. In that way, the ability of the software to handle new MVDs would be increased. Further, the software development tools and techniques accompanying IFC4, particularly mvdXML, make the incorporation of new MVDs much easier for software vendors.

In order to mitigate the problem of identifying additional properties required for product categories, methods are needed to align proprietary

types, hierarchies, and inheritance with the IFC data model. These problems would also be reduced, and user experience and predictability of outcome would be enhanced, if the BIM content included in authoring software products and provided by manufacturers contained the relevant IFC property sets.

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Appendix A: Water System Building Component Occurrences in Revit Models

Table A1 Water system building component occurrences in the Revit models.

--- COMPONENT ---		TYPE	BUILDING OCCURRENCE		
FAMILY:TYPE	IFC	IFC	Duplex	Clinic	Office
Bath Tub Faucet:PT	IfcValve	IfcValveType	*		
Fire Extinguisher Cabinet:305 x 215 x 813mm:305 x 215 x 813mm	IfcFlowTerminal	IfcSanitaryTerminalType		*	
Kitchen Sink Faucet:Kitchen Sink Faucet	IfcValve	IfcValveType	*		
Lavatory Faucet: Lavatory Faucet	IfcValve	IfcValveType	*	*	
M_Backflow Preventer - 15-50 mm:20 mm	IfcFlowController	IfcValveType		*	
M_Backflow Preventer - 15-50 mm:25 mm	IfcFlowController	IfcValveType	*		*
M_Backflow Preventer - 15-50 mm:50 mm	IfcFlowController	IfcValveType			*
M_Ball Valve - 50-150 mm:100 mm	IfcFlowController	IfcValveType		*	
M_Ball Valve - 50-150 mm:150 mm	IfcFlowController	IfcValveType		*	
M_Ball Valve - 50-150 mm:50 mm	IfcFlowController	IfcValveType	*	*	*
M_Ball Valve - 50-150 mm:65 mm	IfcFlowController	IfcValveType		*	
M_Ball Valve - 50-150 mm:80 mm	IfcFlowController	IfcValveType		*	
M_Bath Tub:1525 mmx760 mm - Private	IfcFlowTerminal	IfcSanitaryTerminalType	*		
M_Bend - PVC - Sch 40 - DWV:Bend - PVC - Sch 40 - DWV	IfcPipeFitting	IfcPipeFittingType	*	*	*
M_Drinking Fountain - Rectangular - Wall Mounted:Standard	IfcFlowTerminal	IfcSanitaryTerminalType		*	*
M_Elbow - Generic: Elbow - Generic	IfcPipeFitting	IfcPipeFittingType	*	*	*
M_Floor Drain - Round:125 mm Strainer - 100 mm Drain	IfcPipeFitting	IfcPipeFittingType		*	
M_Hot Water Boiler - 59-440 kW:147 kW	IfcEnergyConversionDevice	IfcBoilerType	*		
M_Inline Pump - Circulator:3.9 LPS - 0.8 Meter Head	IfcFlowMovingDevice	IfcPumpType	*	*	*
M_Lavatory - Oval:535 mmx485 mm - Private	IfcFlowTerminal	IfcSanitaryTerminalType	*		
M_Lavatory - Oval:535 mmx485 mm - Public	IfcFlowTerminal	IfcSanitaryTerminalType		*	*
M_Lavatory - Oval:650 mmx485 mm - Private	IfcFlowTerminal	IfcSanitaryTerminalType	*		
M_Roof Drain:380 mm Strainer - 25 mm Drain	IfcPipeFitting	IfcPipeFittingType	*	*	*
M_Shower Stall - Rectangular:865 mmx815 mm - Private	IfcFlowTerminal	IfcSanitaryTerminalType	*		
M_Shower Stall - Rectangular:915 mmx915 mm - Private	IfcFlowTerminal	IfcSanitaryTerminalType			*
M_Shower Stall - Rectangular:915 mmx915 mm - Public	IfcFlowTerminal	IfcSanitaryTerminalType		*	*

--- COMPONENT ---		TYPE	BUILDING OCCURRENCE		
FAMILY:TYPE	IFC	IFC	Duplex	Clinic	Office
M_Sink - Island - Single:455 mmx455 mm - Private	IfcFlowTerminal	IfcSanitaryTerminalType	*	*	
M_Sink - Kitchen - Double:1065 mmx535 mm - Public	IfcFlowTerminal	IfcSanitaryTerminalType			*
M_Sink - Mop:710 mmx710 mm	IfcFlowTerminal	IfcSanitaryTerminalType		*	
M_Sink - Work:510 mmx455 mm	IfcFlowTerminal	IfcSanitaryTerminalType		*	*
M_Sprinkler - Pendent - Hosted:15 mm Pendent	IfcFlowTerminal	IfcFireSuppression TerminalType		*	*
M_Tee - Generic:Tee - Generic	IfcPipeFitting	IfcPipeFittingType	*	*	*
M_Transition - Generic:Transition - Generic	IfcPipeFitting	IfcPipeFittingType		*	*
M_Urinal - Wall Hung:25 mm Flush Valve	IfcFlowTerminal	IfcSanitaryTerminalType		*	*
M_Water Closet - Flush Tank:Private - 6.1 Lpf	IfcFlowTerminal	IfcSanitaryTerminalType	*		
M_Water Closet - Flush Valve - Wall Mounted:Public - 6.1 Lpf	IfcFlowTerminal	IfcSanitaryTerminalType		*	*
M_Water Heater:380 L	IfcFlowStorageDevice	IfcTankType		*	*
Pipe Types:Cold Water	IfcPipeSement	IfcPipeSementType	*	*	*
Pipe Types:Fire Protection	IfcPipeSement	IfcPipeSementType		*	
Pipe Types:Hot Water	IfcPipeSement	IfcPipeSementType	*	*	*
Pipe Types:PVC	IfcPipeSement	IfcPipeSementType	*		
Pipe Types:Storm	IfcPipeSement	IfcPipeSementType		*	*
Pipe Types:Waste	IfcPipeSement	IfcPipeSementType	*	*	*
Shower-Faucet_Trim-DELTA-Linden-T17294:Polished Chrome	IfcValve	IfcValveType	*	*	

Appendix B: Additional Water System Properties for Revit Families and Model

Table B1. Additional water system properties for the Revit families.

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Backflow Preventer - 15-50 mm:20 mm	Pipe Accessories	IfcValve	*Pset_ValveTypeCommon*
M_Backflow Preventer - 15-50 mm:25 mm			Reference
M_Backflow Preventer - 15-50 mm:50 mm			ValvePattern
			ValveOperation
			ValveMechanism
			Size
			BodyMaterial
			TestPressure
			WorkingPressure
			FlowCoefficient
			CloseRating
			Pset_ValvePHistory
			PercentageOpen
			MeasuredFlowRate
			MeasuredPressureDrop
			Pset_ValveTypePressureReducing
			UpstreamPressure (Instance)
			DownstreamPressure (Instance)

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Ball Valve - 50-150 mm:50 mm	Pipe Accessories	IfcValve	*Pset_ValveTypeCommon*
M_Ball Valve - 50-150 mm:65 mm			Reference
M_Ball Valve - 50-150 mm:80 mm			ValvePattern
M_Ball Valve - 50-150 mm:100 mm			ValveOperation
M_Ball Valve - 50-150 mm:150 mm			ValveMechanism
			Size
			BodyMaterial
			TestPressure
			WorkingPressure
			FlowCoefficient
			CloseRating
			Pset_ValvePHistory
			PercentageOpen
			MeasuredFlowRate
			MeasuredPressureDrop

Family:Type	Revit Category	Ifc Category – MVD	Attributes
Bath Tub Faucet:PT	Plumbing Fixtures	IfcValve	*Pset_ValveTypeFaucet*
Lavatory Faucet: Lavatory Faucet			FaucetType
Kitchen Sink Faucet:Kitchen Sink Faucet			FaucetOperation
Shower-Faucet_Trim-DELTA-Linden-T17294:Polished Chrome			FaucetFunction
			Finish
			FaucetTopDescription
			Pset_ValveTypeMixing
			MixerControl
			OutletConnectionSize
			Pset_ValveTypeCommon
			same as above

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Sink - Island - Single:455 mmx455 mm	Plumbing Fixtures	IfcSanitaryTerminal	*Pset_SanitaryTerminalTypeCommon*
M_Sink - Kitchen - Double:1065 mmx535 mm - Public			Reference
M_Sink - Work:510 mmx455 mm			*Pset_SanitaryTerminalTypeSink*
M_Sink - Mop:710 mmx710 mm			SinkType
			Mounting
			NominalLength
			NominalWidth
			NominalDepth
			Color
			DrainSize
			MountingOffset

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Lavatory - Oval:535 mmx485 mm - Private	Plumbing Fixtures	IfcSanitaryTerminal	*Pset_SanitaryTerminalTypeCommon*
M_Lavatory - Oval:650 mmx485 mm - Private			Reference
M_Lavatory - Oval:535 mmx485 mm - Public			*Pset_SanitaryTerminalTypeWashHandBasin*
			WashHandBasinType
			Mounting
			NominalLength
			NominalWidth
			NominalDepth
			Color
			DrainSize
			MountingOffset

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Drinking Fountain - Rectangular - Wall Mounted:Standard	Plumbing Fixtures	IfcSanitaryTerminal	*Pset_SanitaryTerminalTypeCommon*
			Reference
			Pset_SanitaryTerminalTypeSanitaryFountain
			FountainType
			Mounting
			NominalLength
			NominalWidth
			NominalDepth
			Color
			DrainSize

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Shower Stall - Rectangular:865 mmx815 mm - Private	Plumbing Fixtures	IfcSanitaryTerminal	*Pset_SanitaryTerminalTypeCommon*
M_Shower Stall - Rectangular:915 mmx915 mm - Private			Reference
M_Shower Stall - Rectangular:915 mmx915 mm - Public			*Pset_SanitaryTerminalTypeShower*
			ShowerType
			HasTray
			NominalLength
			NominalWidth
			NominalDepth
			Color
			ShowerHeadDescription
			DrainSize

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Bath Tub:1525 mmx760 mm - Private	Plumbing Fixtures	IfcSanitaryTerminal	*Pset_SanitaryTerminalTypeCommon*
			Reference
			Pset_SanitaryTerminalTypeBath
			BathType
			NominalLength
			NominalWidth
			NominalDepth
			Color
			DrainSize
			HasGrabHandles

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Water Closet - Flush Tank:Private - 6.1 Lpf	Plumbing Fixtures	IfcSanitaryTerminal	*Pset_SanitaryTerminalTypeCommon*
M_Water Closet - Flush Valve - Wall Mounted:Public - 6.1 Lpf			Reference
			Pset_SanitaryTerminalTypeToiletPan
			ToiletType
			ToiletPanType
			PanMounting
			Color
			SpilloverLevel
			NominalLength
			NominalWidth
			NominalDepth

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Urinal - Wall Hung:25 mm Flush Valve	Plumbing Fixtures	IfcSanitaryTerminal	*Pset_SanitaryTerminalTypeCommon*
			Reference
			Pset_SanitaryTerminalTypeUrinal
			UrinalType
			Mounting
			Color
			SpilloverLevel
			NominalLength
			NominalWidth
			NominalDepth

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Inline Pump - Circulator:3.9 LPS - 0.8 Meter Head	Mechanical Equipment	IfcPump	*Pset_PumpOccurrence*
			ImpellerDiameter
			BaseType
			DriveConnectionType
			Pset_PumpPHistory
			MechanicalEfficiency
			OverallEfficiency
			PressureRise
			RotationSpeed
			Flowrate
			Power
			Pset_PumpTypeCommon
			Reference
			Status *(Instance)*
			FlowRateRange
			FlowResistanceRange

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Inline Pump - Circulator:3.9 LPS - 0.8 Meter Head (cont'd.)	Mechanical Equipment (cont'd.)	IfcPump (cont'd.)	ConnectionSize
			TemperatureRange
			NetPositiveSuctionHead
			NominalRotationSpeed

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Hot Water Boiler - 59-440 kW:147 kW	Mechanical Equipment	IfcBoiler	*Pset_BoilerPHistory*
M_Water Heater:380 L			EnergySourceConsumption
			OperationalEfficiency
			CombustionEfficiency
			WorkingPressure
			CombustionTemperature
			PartLoadRatio
			Load
			PrimaryEnergyConsumption
			AuxiliaryEnergyConsumption
			Pset_BoilerTypeCommon
			Reference
			Status *(Instance)*
			PressureRating
			OperatingMode
			HeatTransferSurfaceArea
			NominalPartLoadRatio
			WaterInletTemperatureRange
			WaterStorageCapacity
			IsWaterStorageHeater
			PartialLoadEfficiencyCurves
			OutletTemperatureRange
			NominalEnergyConsumption
			EnergySource
			Pset_BoilerTypeWater
			NominalEfficiency
			HeatOutput

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Roof Drain:380 mm Strainer - 25 mm Drain	Mechanical Equipment	IfcWasteTerminalType	*Pset_WasteTerminalTypeCommon*
M_Floor Drain - Round:125 mm Strainer - 100 mm Drain			Reference
			Status *(Instance)*
			Pset_WasteTerminalTypeFloorWaste
			NominalLength
			NominalWidth
			NominalDepth
			OutletConnectionSize
			CoverLength
			CoverWidth
			Pset_WasteTerminalTypeFloorWaste
			NominalLength
			NominalWidth
			NominalDepth
			OutletConnectionSize
			CoverLength
			CoverWidth

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Elbow - Generic: Elbow - Generic	Pipe Fittings	IfcPipeFitting	*Pset_PipeFittingTypeCommon*
M_Transition - Generic:Transition - Generic			Reference
			Status *(Instance)*
			PressureClass
			PressureRange
			TemperatureRange
			FittingLossFactor
			Pset_PipeFittingOccurrence
			InteriorRoughnessCoefficient
			Color
			Pset_PipeFittingPHistory
			LossCoefficient
			FlowrateLeakage

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Bend - PVC - Sch 40 - DWV:Bend - PVC - Sch 40 - DWV	Pipe Fittings	IfcPipeFitting	*Pset_PipeFittingTypeCommon*
			Same as Above
			Pset_PipeFittingTypeBend
			BendAngle
			BendRadius

Family:Type	Revit Category	Ifc Category – MVD	Attributes
M_Tee - Generic:Tee - Generic	Pipe Fittings	IfcPipeFitting	*Pset_PipeFittingTypeCommon*
			Same as Above
			Pset_PipeFittingTypeJunction
			JunctionType
			JunctionLeftAngle
			JunctionLeftRadius
			JunctionRightAngle
			JunctionRightRadius

Family:Type	Revit Category	Ifc Category – MVD	Attributes
Pipe Types: PVC	Pipes	IfcPipeSegment	*Pset_PipeSegmentTypeCommon*
Pipe Types:Waste			Reference
Pipe Types:Cold Water			Status *(Instance)*
Pipe Types:Hot Water			WorkingPressure
Pipe Types:Fire Protection			PressureRange
Pipe Types:Storm			TemperatureRange
			NominalDiameter
			InnerDiameter
			OuterDiameter
			Pset_PipeSegmentOccurrence
			InteriorRoughnessCoefficient
			Color
			Gradient
			InvertElevation
			Pset_PipeSegmentPHistory
			LeakageCurve
			FluidFlowLeakage

Table B2. Additional project properties for to the file not associated with individual elements

Revit Category	Ifc Category - MVD	ATTRIBUTES *Pset_BuildingCommon*
N/A	*IfcBuiliding*	Reference
		BuildingID
		IsPermanentID
		ConstructionMethod
		FireProtectionClass
		SprinklerProtection
		SprinklerProtectionAutomatic
		OccupancyType
		GrossPlannedArea
		NetPlannedArea
		NumberOfStoreys
		YearOfConstruction
		YearOfLastRefurbishment
		IsLandmarked

Appendix C: Sample Validation Report

Table C1. Water system exchanges.

Number	Exchange Name
1	Facility Occupancy Model
2	Compare System Options
3	Locate Plumbing Fixtures
4	Plumbing Equipment Requirements
5	Plumbing Spatial Requirements
6	Locate and Size Plumbing Equipment Rooms
7	Specify Plumbing System Performance
8	Size Plumbing System
9	Plumbing Basis of Design
10	Document Plumbing Design Schematic
11	Coordinate With Other Building Systems
12	Facility Spatial Configuration
13	Water Supply Requirements
14	Calculate Water Balance
15	Piping Schematic
16	Layout Plumbing System
17	Piping and Equipment Sizes
18	Product Type Specifications
19	Document Coordinated Design

Table C2 Validation test results symbols used in Table C3.

Symbol	Meaning	Flag Column
-	The test was inapplicable for the particular exchange	A "-" indicates that the test does not apply to any of the exchanges
+	The entity or concept passed the test for the given exchange	A "+" indicates that the test passes for all applicable exchanges
*	An optional rule for the particular exchange failed the test	An "*" indicates that the optional test failed at least one of the applicable exchanges
F	A mandatory rule for the particular exchange failed the test	An "F" indicates that the mandatory test failed at least one of the applicable exchanges
R	Required concept (Req column)	
O	Optional concept (Req column)	
#<number>	The number identifies the first object instance that violates the rule – the numbers correspond to those in the IFC file. (Errors column)	
<number>	Number of instances subject to the rule (Count column)	

Notes:

1. The "Count" column in Table C3 indicates the number of instances subject to the rule.
2. The "Flag" column in Table C3 indicates if any of the exchanges have failures.

Table C3. Clinic Water System MVD IFC validation.

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
IfcProject			1																				
Identity	R		1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Spatial Decomposition	R																						
Spatial Parts=IfcSite;			1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Project Units	O																						
NamedUnitType=LENGTHUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=TIMEUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=FREQUENCYUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=AREAUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=THERMODYNAMICTEMPERATUREUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=PRESSUREUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=VOLUMEUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Project Context	O																						
ContextIdentifier=Plan; ContextType=2D;			1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
ContextIdentifier=Model; ContextType=3D;			1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Project Declaration [IFC4]	O																						
Type=IfcSpaceType;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Type=IfcOccupant;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Type=IfcActor;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Type=IfcSpace;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Type=IfcWorkPlan;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Type=IfcDistributionElementType;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Type=IfcDistributionSystem;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
IfcSite			1																				
Identity	R		1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Site Location	R	#2448304	0	F	*	*	*	*	*	*	*	*	*	*	*	*	F	*	*	*	*	*	F

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Spatial Decomposition	R																						
Spatial Parts=IfcBuilding;			1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Footprint Geometry	O																						
RepresentationType=GeometricCurveSet ; Geometry=IfcGeometricCurveSet;		#2448 304	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
RepresentationType=Annotation2D; Geometry=IfcAnnotationFillArea;		#2448 304	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
IfcBuilding			1																				
Identity	R		1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Classification [IFC4]	R																						
Source=CSI; Name=OmniClass; Tokens=11-00 00 00;		#57	0	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Property Sets	O																						
Name=Pset_BuildingCommon;		#57	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Product Assignment	R																						
Type=IfcTask;		#57	0	F	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Decomposition	R																						
Spatial Parts=IfcBuildingStorey;			1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Building Location	R	#57	0	F	*	F	*	F	*	*	*	*	*	*	*	*	F	*	*	*	*	*	F
IfcTask			0																				
Identity	R		0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Process Assignment	R																						
Type=IfcSubContractResource;			0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Type= IfcConstructionProductResource;			0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcConstructionProductResource			0																				
Identity	R		0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resource Cost	O																						
CostType=IfcCostValue; CostName=Product; ValueType=IfcMonetaryMeasure;			0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
CostType=IfcCostValue; CostName=Shipping; ValueType=IfcMonetaryMeasure;			0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resource Quantity	R																						
QuantityType=IfcQuantityCount; QuantityName=Count;			0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resource Assignment	R																						
Type=IfcSanitaryTerminal;			0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcOccupant			0																				
Identity	R		0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Actor Assignment	O																						
Type=IfcSpatialStructureElement;			0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Type=IfcWorkCalendar;			0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contact	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcActor			0																				
Identity	R		0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	O																						
Name=Pset_ActorCommon; TemplateType= PSET_OCCURRENCEDRIVEN;			0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contact	R																						
Role=USERDEFINED; UserDefinedRole=ElectricalUtility;			0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Actor Assignment	R																						
Type=IfcWorkPlan;			0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcSanitaryTerminal			0																				
Identity	R		0	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Object Typing	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	R																						
PredefinedType=BATH; Name=Pset_SanitaryTerminalTypeBath;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
PredefinedType=BIDET; Name=Pset_SanitaryTerminalTypeBidet; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=CISTERN; Name= Pset_SanitaryTerminalTypeCistern; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Name= Pset_SanitaryTerminalTypeCommon; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType= SANITARYFOUNTAIN; Name=Pset_SanitaryTerminalType SanitaryFountain; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=SHOWER; Name= Pset_SanitaryTerminalTypeShower; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=SINK; Name=Pset_SanitaryTerminalTypeSink; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=TOILETPAN; Name= Pset_SanitaryTerminalTypeToiletPan; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=URINAL; Name= Pset_SanitaryTerminalTypeUrinal; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=WASHHANDBASIN; Name=Pset_SanitaryTerminal TypeWashHandBasin;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Quantity Sets	O																						
Name= Qto_SanitaryTerminalBaseQuantities;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Ports [IFC4]	R																						
PredefinedType=BATH; Name=ColdWater; Type=DOMESTICCOLDWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
PredefinedType=BATH; Name=HotWater; Type=DOMESTICHOTWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=BATH; Name=Drainage; Type=DRAINAGE; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=BIDET; Name=ColdWater;Type= DOMESTICCOLDWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=BIDET; Name=HotWater;Type= DOMESTICHOTWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=BIDET; Name=Drainage; Type=DRAINAGE; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=CISTERN; Name=ColdWater;Type= DOMESTICCOLDWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=CISTERN; Name=HotWater;Type= DOMESTICHOTWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=CISTERN; Name=Drainage; Type=DRAINAGE; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType= SANITARYFOUNTAIN;Name=ColdWater ;Type=DOMESTICCOLDWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType= SANITARYFOUNTAIN;Name=HotWater; Type=DOMESTICHOTWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType= SANITARYFOUNTAIN; Name=Drainage; Type=DRAINAGE; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=SHOWER; Name=ColdWater;Type= DOMESTICCOLDWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=SHOWER; Name=HotWater;Type= DOMESTICHOTWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=SHOWER; Name=Drainage; Type=DRAINAGE; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
PredefinedType=SINK;Name= ColdWater;Type= DOMESTICCOLDWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=SINK;Name= HotWater;Type= DOMESTICHOTWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=SINK; Name=Drainage; Type=DRAINAGE; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=TOILETPAN; Name=ColdWater;Type= DOMESTICCOLDWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=TOILETPAN; Name=Drainage; Type=DRAINAGE; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=URINAL; Name=ColdWater;Type= DOMESTICCOLDWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=URINAL; Name=Drainage; Type=DRAINAGE; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=WASHHANDBASIN; Name=ColdWater;Type= DOMESTICCOLDWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=WASHHANDBASIN; Name=HotWater;Type= DOMESTICHOTWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=WASHHANDBASIN; Name=Drainage; Type=DRAINAGE; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Product Placement	R																						
Type=IfcLocalPlacement;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Footprint Geometry	R																						
RepresentationType=GeometricCurveSet ; Geometry=IfcGeometricCurveSet;			0	+	-	-	+	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Body Geometry	R																						
RepresentationType= MappedRepresentation;Geomtry= IfcMappedItem;			0	+	-	-	+	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Clearance Geometry	O		0	+	-	-	+	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Element Connectivity	O																						
Type=IfcSlab;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Type=IfcCovering;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Type=IfcSystemFurnitureElement;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcSanitaryTerminalType			9																				
Identity	R		9	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R																						
Name= Pset_SanitaryTerminalCommon;		#1794 8	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F
Type-Based Ports [IFC4]	R	#1794 8	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F
Body Geometry	R																						
RepresentationType=Brep; Geomtry=IfcFacetedBrep;			9	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Clearance Geometry	R																						
Type=SurfaceModel; Geomtry=IfcFaceBasedSurfaceModel;			9	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
IfcWasteTerminal			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Object Typing	R																						
Type=IfcWasteTerminalType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	R																						
PredefinedType=;Name= Pset_WasteTerminalTypeCommon;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=FLOORTRAP; Name=Pset_WasteTerminalTypeFloorTrap;TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=FLOORWASTE; Name= Pset_WasteTerminalTypeFloorWaste; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
PredefinedType=GULLYSUMP; Name= Pset_WasteTerminalTypeGullySump; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=GULLYTRAP; Name= Pset_WasteTerminalTypeGullyTrap; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=ROOFDRAIN; Name= Pset_WasteTerminalTypeRoofDrain; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType= WASTEDISPOSALUNIT;Name= Pset_WasteTerminalTypeWaste DisposalUnit;TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=WASTETRAP; Name= Pset_WasteTerminalTypeWasteTrap;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Quantity Sets	O																						
Name= Qto_WasteTerminalBaseQuantities;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Ports [IFC4]	R																						
PredefinedType=FLOORTRAP; Name=Inlet; Type=DRAINAGE; Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=FLOORTRAP; Name=Outlet; Type=DRAINAGE; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=FLOORWASTE; Name=Inlet; Type=WASTE; Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=FLOORWASTE; Name=Outlet; Type=WASTE; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=GULLYSUMP; Name=Inlet; Type=WASTE; Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=GULLYSUMP; Name=Inlet; Type=WASTE; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=GULLYTRAP; Name=Inlet; Type=WASTE; Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
PredefinedType=GULLYTRAP; Name=Inlet; Type=WASTE; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=ROOFDRAIN; Name=Outlet; Type=RAINWATER; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=WASTEDISPOSALUNIT; Name=Inlet; Type=WASTE; Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType= WASTEDISPOSALUNIT; Name=Outlet; Type=WASTE; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=WASTETRAP; Name=Inlet; Type=WASTE; Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=WASTETRAP; Name=Outlet; Type=WASTE; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Body Geometry	R																						
RepresentationType= MappedRepresentation; Geomtry=IfcMappedItem;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Clearance Geometry	O		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcPipeFitting			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+
Object Typing	R																						
Type=IfcPipeFittingType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	R																						
PredefinedType=; Name=Pset_PipeFittingOccurrence;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
Name=Pset_PipeFittingPHistory; TemplateType= PSET_PERFORMANCEDRIVEN;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
PredefinedType=BEND; Name=Pset_PipeFittingTypeBend; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
Name=Pset_PipeFittingTypeCommon; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
PredefinedType=JUNCTION; Name=Pset_PipeFittingTypeJunction;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
Quantity Sets	R																						
Name=Qto_PipeFittingBaseQuantities;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Ports [IFC4]	R																						
PredefinedType=BEND; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
PredefinedType=BEND; Name=Outlet; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
PredefinedType=CONNECTOR; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
PredefinedType=CONNECTOR; Name=Outlet; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
PredefinedType=ENTRY; Name=Outlet; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
PredefinedType=EXIT; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
PredefinedType=JUNCTION; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
PredefinedType=JUNCTION; Name=Outlet#1; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
PredefinedType=JUNCTION; Name=Outlet#2; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
PredefinedType=OBSTRUCTION; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
PredefinedType=OBSTRUCTION; Name=Outlet; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
IfcPipeFittingType			372																				
Identity	R		372	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R	#3783	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F
IfcPipeSegment			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Object Typing	R																						
Type=IfcPipeSegmentType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	R																						
PredefinedType=; Name=Pset_PipeConnectionFlanged;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
Name=Pset_PipeSegmentOccurrence; TemplateType=PSET_OCCURRENCEDRIVEN;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
Name=Pset_PipeSegmentPHistory; TemplateType= PSET_PERFORMANCEDRIVEN;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
Name= Pset_PipeSegmentTypeCommon; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
PredefinedType=CULVERT; Name=Pset_PipeSegmentTypeCulvert; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
PredefinedType=GUTTER; Name=Pset_PipeSegmentTypeGutter;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
Quantity Sets	R																						
Name= Qto_PipeSegmentBaseQuantities;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Material Profile Set Usage [IFC4]	R																						
Name=Casing;			0	+	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+
Name=Coating;			0	+	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+
Name=Insulation;			0	+	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+
Name=Lining;			0	+	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+
Ports [IFC4]	R																						
Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+
Name=Outlet; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+
Interference	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Axis Geometry	R																						

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
RepresentationType=Curve3D; Geometry=IfcPolyline;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Body Geometry	R																						
RepresentationType= MappedRepresentation; Geometry= IfcMappedItem;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+
RepresentationType=SweptSolid; Geometry=IfcExtrudedAreaSolid;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+
IfcPipeSegmentType			6																				
Identity	R		6	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R	#825	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F
Material Profile Set [IFC4]	R	#825	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F
IfcPump			0																				
Identity	R		0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Object Typing	R																						
Type=IfcPumpType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	R		0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Quantity Sets	O																						
Name=Qto_PumpBaseQuantities;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Ports [IFC4]	R																						
Name=Power; Type=ELECTRICAL; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Name=Outlet; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Spatial Containment	R		0	+	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Body Geometry	R																						
RepresentationType= MappedRepresentation; Geometry= IfcMappedItem;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcPumpType			1																				
Identity	R		1	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R	#1036 542	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Type-Based Ports [IFC4]	R	#1036542	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F
IfcDistributionPort			13058																				
Identity	R		13058	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Property Sets	R																						
PredefinedType=PIPE; Name=Pset_DistributionPortTypePipe;		#2415657	0	F	-	-	*	*	*	*	*	F	*	*	*	*	F	F	F	F	F	F	F
Material Profile Set Usage [IFC4]	R																						
Name=Pipe; Profile=IfcCircleHollowProfileDef;		#2415657	0	F	-	-	-	-	-	-	-	-	-	F	F	F	F	F	F	F	F	F	F
Port Connectivity	R	#2415659	6529	F	-	-	-	-	-	-	-	-	-	F	F	F	F	F	F	F	F	F	F
Product Placement	R		13058	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
IfcDistributionSystem			0																				
Identity	R		0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	R																						
PredefinedType=; Name=Pset_DistributionSystemCommon;			0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DOMESTICCOLDWATER; Name=Pset_DistributionSystemTypePlumbing;			0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Aggregation	O																						
PredefinedType=; RelatedObjects=IfcDistributionCircuit;			0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Group Assignment	O																						
Type=IfcSanitaryTerminal;			0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Type=IfcPump;			0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Type=IfcValve;			0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Type=IfcBoiler;			0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Type=IfcWasteTerminal;			0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Type=IfcFilter;			0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcBoiler			0																				
Identity	R		0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Object Typing	R																						

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Type=IfcBoilerType;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Property Sets	R																						
PredefinedType=; Name=Pset_BoilerPHistory;			0	+	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Name=Pset_BoilerTypeCommon; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=STEAM; Name=Pset_BoilerTypeSteam; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=WATER; Name=Pset_BoilerTypeWater;			0	+	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Quantity Sets	O																						
Name=Qto_BoilerBaseQuantities;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Ports [IFC4]	R																						
PredefinedType=WATER; Name=Gas; Flow=SINK; Type=GAS;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=WATER; Name= Exhaust; Type= EXHAUST; Flow=SOURCE			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=WATER;Name= ColdWater;Type= DOMESTICCOLDWATER; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=WATER;Name= HotWater;Type= DOMESTICHOTWATER;Flow=SOURCE			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Body Geometry	R																						
RepresentationType= MappedRepresentation; Geometry= IfcMappedItem;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+
Clearance Geometry	O		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+
IfcBoilerType			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
IfcFlowMeter			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+
Object Typing	R																						

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Type=IfcFlowMeterType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	O																						
PredefinedType=; Name=Pset_FlowMeterOccurrence;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Name=Pset_FlowMeterTypeCommon; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=ENERGYMETER; Name= Pset_FlowMeterTypeEnergyMeter;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Ports [IFC4]	R																						
PredefinedType=GASMETER; Name=Inlet; Flow=SINK; Type=GAS;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=GASMETER;Name=Outlet; Type=GAS; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=WATERMETER; Name=Inlet; Flow=SINK; Type=DOMESTICCOLDWATER;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=WATERMETER; Name=Outlet;Type= DOMESTICCOLDWATER; Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Product Placement	-																						
Type=IfcLocalPlacement;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Body Geometry	R																						
RepresentationType= MappedRepresentation; Geometry= IfcMappedItem;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Spatial Containment	R																						
Structure=IfcSite;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcFlowMeterType			0																				
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Type-Based Ports [IFC4]	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
IfcValve			0																				
Identity	R		0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Object Typing	R																						
Type=IfcValveType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	R																						
PredefinedType=; Name=Pset_ValvePHistory;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=AIRRELEASE; Name=Pset_ValveTypeAirRelease; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Name=Pset_ValveTypeCommon; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=DRAWOFFCOCK; Name=Pset_ValveTypeDrawOffCock; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=FAUCET; Name=Pset_ValveTypeFaucet; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=FLUSHING; Name=Pset_ValveTypeFlushing; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=GASTAP; Name=Pset_ValveTypeGasTap; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=ISOLATING; Name=Pset_ValveTypeIsolating; TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=MIXING; Name=Pset_ValveTypeMixing; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType= PRESSUREREDUCING; Name= Pset_ValveTypePressureReducing; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=PRESSURERELIEF; Name=Pset_ValveTypePressureRelief;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Quantity Sets	O																						
Name=Qto_ValveBaseQuantities;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Material Constituents	-																						
Name=Casing;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Operation;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Connectivity	R																						
Type=IfcActuator; Relation= IfcRelFlowControlElements;			0	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+
Ports [IFC4]	R																						
PredefinedType=AIRHANDLER; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=ANTIVACUUM; Name=Outlet; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=CHANGEOVER; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=CHANGEOVER; Name=Outlet#1; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=CHANGEOVER; Name=Outlet#2; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=CHECK; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=CHECK; Name=Outlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=COMMISSIONING; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=COMMISSIONING; Name=Outlet; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=DIVERTING; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=DIVERTING; Name=Outlet#1; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
PredefinedType=DIVERTING; Name=Outlet#2; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=DOUBLECHECK; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=DOUBLECHECK; Name=Outlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType= DOUBLEREGULATING; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType= DOUBLEREGULATING; Name=Outlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=DRAWOFFCOCK; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=FAUCET; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=FLUSHING; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=FLUSHING; Name=Outlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=GASCOCK; Name=Inlet; Type=GAS; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=GASTAP; Name=Inlet; Type=GAS; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=ISOLATING; Name=Inlet; Type=GAS; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=ISOLATING; Name=Outlet; Type=GAS; Flow=SOURCE			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=MIXING; Name=Inlet#1; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=MIXING; Name=Inlet#2; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=MIXING; Name=Outlet; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
PredefinedType= PRESSUREREDUCING; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType= PRESSUREREDUCING; Name=Outlet; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=PRESSURERELIEF; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=REGULATING; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=REGULATING; Name=Inlet; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=SAFETYCUTOFF; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=SAFETYCUTOFF; Name=Outlet; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=STEAMTRAP; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=STEAMTRAP; Name=Outlet; Type=NOTDEFINED; Flow=SOURCE			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=STOPCOCK; Name=Inlet; Type=NOTDEFINED; Flow=SINK			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Body Geometry	R																						
RepresentationType= MappedRepresentation; Geometry= IfcMappedItem;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcValveType			10																				
Identity	R		10	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R	#654054	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F
Type-Based Ports [IFC4]	R	#654054	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F
IfcWorkCalendar			0																				
Identity	R		0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Object Nesting	O																						
Type=IfcCostSchedule;			0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calendar	R		0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Control Assignment	R																						
Type=IfcSpatialStructureElement;			0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcSubContractResourceType			0																				
Identity	R		0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resource Cost Rate	R		0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcSubContractResource			0																				
Identity	R		0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resource Cost	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resource Quantity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resource Assignment	-																						
Type=IfcActor;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcBuildingStorey			3																				
Identity	R		3	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Property Sets	O																						
Name=Pset_BuildingStoreyCommon; TemplateType= PSET_OCCURRENCEDRIVEN;		#62	0	*	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Building Storey Elevation	R		3	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Spatial Decomposition	R																						
Spatial Parts=IfcSpace;		#62	0	F	-	-	F	*	F	F	*	*	*	*	*	F	*	*	*	*	*	*	F
IfcSpace			0																				
Identity	R		0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Object Typing	O																						
Type=IfcSpaceType;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Classification [IFC4]	R																						

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Source=CSI; Name=OmniClass; Tokens= 13-00 00 00;			0	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Property Sets	O																						
PredefinedType=;Name= Pset_SpaceOccupancyRequirements;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=; Name=Pset_SpaceCommon;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Quantity Sets	O																						
Name=Qto_SpaceBaseQuantities; TemplateType= QTO_OCCURRENCEDRIVEN;			0	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+
Space Boundaries	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Placement	R																						
Type=IfcLocalPlacement;			0	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+
Footprint Geometry	R																						
RepresentationType=GeometricCurveSet ; Geometry=IfcGeometricCurveSet;			0	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+
Body Geometry	R																						
RepresentationType=SweptSolid; Geometry=IfcExtrudedAreaSolid;			0	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+
RepresentationType=Clipping; Geometry= IfcBooleanClippingResult;			0	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+
RepresentationType=Brep; Geometry= IfcFacetedBrep;			0	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+
IfcElectricAppliance			0																				
Identity	R		0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Object Typing	R																						
Type=IfcElectricApplianceType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	R																						
PredefinedType=; Name=Pset_ElectricAppliancePHistory;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Name= Pset_ElectricApplianceTypeCommon; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
PredefinedType=DISHWASHER; Name= Pset_ElectricApplianceTypeDishwasher;			0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ports [IFC4]	R																						
PredefinedType=DISHWASHER; Name=HotWater; Flow=SINK; Type=DOMESTICHOTWATER;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=DISHWASHER; Name=Drainage; Type=DRAINAGE; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=FRIDGE_FREEZER; Name=ColdWater; Flow=SINK; Type=DOMESTICCOLDWATER;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=WASHINGMACHINE; Name=ColdWater; Flow=SINK; Type=DOMESTICCOLDWATER;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=WASHINGMACHINE; Name=HotWater;Type= DOMESTICHOTWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=WASHINGMACHINE; Name=Drainage; Type=DRAINAGE; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Body Geometry	R																						
RepresentationType= MappedRepresentation; Geometry= IfcMappedItem;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcElectricApplianceType			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Type-Based Ports [IFC4]	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
IfcSolarDevice			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Object Typing	R																						
Type=IfcSolarDeviceType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	O																						
PredefinedType=; Name=Pset_SolarDeviceTypeCommon;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Ports [IFC4]	R																						

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
PredefinedType= SOLARCOLLECTOR; Name=Inlet; Flow=SOURCE; Type=HEATING;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType= SOLARCOLLECTOR; Name=Outlet; Flow=SINK; Type=HEATING;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Body Geometry	R																						
RepresentationType= MappedRepresentation; Geometry= IfcMappedItem;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcFilterType			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Type-Based Ports [IFC4]	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
IfcFilter			0																				
Identity	R		0	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Object Typing	R																						
Type=IfcFilterType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	R																						
PredefinedType=; Name=Pset_FilterPHistory;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=; Name=Pset_FilterTypeCommon;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=WATERFILTER; Name=Pset_FilterTypeWaterFilter;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ports [IFC4]	R																						
PredefinedType=ODORFILTER;Name= Inlet; Flow=SINK; Type=EXHAUST;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=ODORFILTER; Name=Outlet; Type=EXHAUST; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=STRAINER; Name=Inlet; Flow=SINK; Type=DRAINAGE;			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=STRAINER; Name=Outlet; Type=DRAINAGE; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
PredefinedType=WATERFILTER; Name=Inlet;Type= DOMESTICCOLDWATER; Flow=SINK			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PredefinedType=WATERFILTER; Name=Outlet;Type= DOMESTICCOLDWATER; Flow=SOURCE			0	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Spatial Containment	R		0	+	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Body Geometry	R																						
RepresentationType= MappedRepresentation; Geometry= IfcMappedItem;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcWasteTerminalType			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Type-Based Ports [IFC4]	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Body Geometry	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Clearance Geometry	R																						
Type=SurfaceModel; Geometry= IfcFaceBasedSurfaceModel;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
IfcPerformanceHistory			0																				
Identity	R		0	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets for Performance	R																						
Name= Pset_DistributionPortPHistoryPipe;			0	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Name= Pset_UtilityConsumptionPHistory;			0	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Control Assignment	R																						
Type=IfcGroup;			0	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Type=IfcProduct;			0	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
IfcSystemFurnitureElement			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Object Typing	R																						
Type= IfcSystemFurnitureElementType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	O																						

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
PredefinedType=; Name=Pset_SystemFurniture ElementTypeCommon;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
PredefinedType=PANEL; Name=Pset_SystemFurniture ElementTypePanel; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
PredefinedType=WORKSURFACE; Name=Pset_SystemFurniture ElementTypeWorkSurface;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Material Constituents	O																						
Name=Finish;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Name=Frame;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Name=Hardware;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Name=Padding;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Name=Panel;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Product Placement	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Body Geometry	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
IfcSystemFurnitureElementType			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
IfcCostSchedule			0																				
Identity	R		0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Nesting	O																						
Type=IfcCostItem;			0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcSolarDeviceType			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Type-Based Ports [IFC4]	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Body Geometry	R																						
RepresentationType=Brep; Geometry= IfcFacetedBrep;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Clearance Geometry	O																						

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Type=SurfaceModel; Geometry= IfcFaceBasedSurfaceModel;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
IfcWallElementedCase			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Object Aggregation	O																						
PredefinedType=; RelatedObjects=IfcMember;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=; RelatedObjects=IfcPlate;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=; RelatedObjects=IfcBuildingElementPart;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=; RelatedObjects= IfcBeam;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Product Placement	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Axis Geometry	R																						
RepresentationType=Curve2D; Geometry=IfcBoundedCurve;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Surface Geometry	O																						
RepresentationType=Surface3D; Geometry=IfcBoundedSurface;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Spatial Containment	R																						
Structure=IfcSite;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Structure=IfcBuildingStorey;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcSlabElementedCase			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Object Aggregation	O																						
PredefinedType=; RelatedObjects=IfcBeam;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=; RelatedObjects=IfcPlate;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
PredefinedType=; RelatedObjects=IfcBuildingElementPart;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Product Placement	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Surface Geometry	O																						

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
RepresentationType=Surface3D; Geometry=IfcBoundedSurface;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Spatial Containment	R																						
Structure=IfcBuildingStorey;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcMember			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Object Typing	R																						
Type=IfcMemberType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	O																						
Name=Pset_MemberCommon; TemplateType= PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Material Profile Set [IFC4]	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+
Product Placement	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+
Axis Geometry	R																						
Rep Identifier=Axis; Identifier=; RepresentationType=Curve3D; Type=; Geometry=IfcBoundedCurve;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+
Body Geometry	R																						
RepresentationType=SweptSolid; Geometry=IfcExtrudedAreaSolid;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+
RepresentationType=Clipping; Geometry=IfcBooleanClippingResult;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+
RepresentationType=AdvancedSweptSolid; Geometry=IfcSweptAreaSolid;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+
RepresentationType=SurfaceModel; Geometry=IfcFaceBasedSurfaceModel;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+
RepresentationType=Brep; Geometry=IfcFacetedBrep;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+
RepresentationType= MappedRepresentation; Geometry= IfcMappedItem;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+
IfcSlabStandardCase			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Object Typing	O																						

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Type=IfcSlabType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Material Layer Set Usage	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Body Geometry	R																						
RepresentationType=SweptSolid; Geometry=IfcExtrudedAreaSolid;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
RepresentationType=Clipping; Geometry=IfcBooleanClippingResult;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcWall			0																				
Path Connectivity	R																						
RelatedElement=IfcWall;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Voiding	R																						
RelatedOpening=IfcOpeningElement;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcOpeningElement			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Product Placement	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Body Geometry	R																						
RepresentationType=SweptSolid; Geometry=IfcExtrudedAreaSolid;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
RepresentationType=Brep; Geometry=IfcFacetedBrep;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcOpeningStandardCase			0																				
IfcWallStandardCase			0																				
Identity	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Object Typing	O																						
Type=IfcWallType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Material Layer Set Usage	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Axis Geometry	R																						
RepresentationType=Curve2D; Geometry=IfcBoundedCurve;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
Body Geometry	R																						
RepresentationType=SweptSolid; Geometry=IfcExtrudedAreaSolid;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
RepresentationType=Clipping; Geometry=IfcBooleanClippingResult;			0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
IfcSlab			0																				
Voiding	R		0	+	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
SUMMARY FOR IFC4					99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	98%	99%	99%	99%	99%	96%	96%
SUMMARY FOR IFC2X3					99%	99%	99%	99%	99%	99%	100%	99%	100%	99%	99%	99%	99%	99%	99%	99%	99%	98%	97%

Table C4. Summary of water system MVD IFC validation.

Duplex Apartment																				
		Exchange																		
	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Test was inapplicable for the particular exchange (-)	11	372	368	323	264	264	258	253	258	251	161	161	154	154	154	131	120	120	59	52
Entity or concept passed the test for the given exchange (+)	368	25	30	69	129	129	135	140	135	142	230	230	236	236	236	259	270	270	322	329
Optional rule for the particular exchange failed the test (*)	22	19	18	24	23	23	23	24	23	24	24	24	24	22	24	24	24	24	24	21
Mandatory rule for the particular exchange failed the test (F)	18	3	3	3	3	3	3	2	3	2	4	4	5	7	5	5	5	5	14	17
Total Tests	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419
Office Building																				
		Exchange																		
	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Test was inapplicable for the particular exchange (-)	11	372	368	323	264	264	258	253	258	251	161	161	154	154	154	131	120	120	59	52
Entity or concept passed the test for the given exchange (+)	368	25	30	69	129	129	135	140	135	142	230	230	236	236	236	259	270	270	322	329
Optional rule for the particular exchange failed the test (*)	22	19	18	24	23	23	23	24	23	24	24	24	24	22	24	24	24	24	24	21
Mandatory rule for the particular exchange failed the test (F)	18	3	3	3	3	3	3	2	3	2	4	4	5	7	5	5	5	5	14	17
Total Tests	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419
Medical Clinic																				
		Exchange																		
	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Test was inapplicable for the particular exchange (-)	11	372	368	323	264	264	258	253	258	251	161	161	154	154	154	131	120	120	59	52
Entity or concept passed the test for the given exchange (+)	373	26	31	73	133	133	139	144	139	146	234	234	241	241	241	264	275	275	327	334
Optional rule for the particular exchange failed the test (*)	18	19	18	21	20	20	20	21	20	21	21	21	20	18	20	20	20	20	20	17
Mandatory rule for the particular exchange failed the test (F)	17	2	2	2	2	2	2	1	2	1	3	3	4	6	4	4	4	4	13	16
Total Tests	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419

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14. ABSTRACT

Previous efforts by the US Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) to develop a life-cycle building model have resulted in the definition of a "core" building information model that contains general information describing facility assets such as spaces and equipment. To describe how facility assets (i.e., components) function together, information about assemblies of assets and their connections must also be defined. The definitions of assets, assemblies, and connections for the various building-information domains are discipline-specific. Work documented in ERDC/CERL CR-13-4 identified the processes and tasks specifically associated with the design of interior plumbing systems and the information exchange requirements for every participant in the design. The findings were used to develop an information-exchange Model View Definition (MVD) for building water systems.

The objective of the current work was to document the steps needed to identify the plumbing MVD attributes in three experimental building information models representing typical low-rise Army facilities, and to update those models. This work also validated the International Foundation Class (IFC) export function from the experimental models against the water system MVD, and studied the requirements for creating computable open building models that can be utilized for the automated information exchanges.

15. SUBJECT TERMS
information exchange, interior plumbing systems, product data templates, guide specifications, Construction Operations Building information exchange (COBie), Building Information Modeling (BIM)

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